REVIEW

International Journal of Surgery (2013) **11**(S1), S20–S23

Contents lists available at ScienceDirect

International Journal of Surgery

journal homepage: www.journal-surgery.net

REVIEW

Surgical approach to abdominal wall defects: history and new trends

Francesco Basile, Antonio Biondi, Marcello Donati

Department of Surgery, General and Oncologic Surgery Unit, Vittorio-Emanuele University Hospital of Catania, Italy

ARTICLE INFO

Keywords:
Hernia repair
History of hernia repair
Prosthetic repair
New trends
Incisional hernias
Inguinal hernia

ABSTRACT

We briefly outline the history of hernia surgery development from the Ebers Papyrus to modern prosthetic repairs. The rapid evolution of anatomical, physiological and pathogenetic concepts has involved the rapid evolution of surgical treatments. From hernia sack cauterization to sack ligation, posterior wall repair (Bassini), and prosthetic reinforcement there has been an evident improvement in surgical treatment results that has stimulated surgeons to find new technical solutions over time. The introduction of prosthetic repair, the laparoscopic revolution, the impact of local anesthesia and the diffusion of day surgery have been the main advances of the last 50 years. Searching for new gold standards, the introduction of new devices has also led to new complications and problems. Research of the last 10 years has been directed to overcome prosthetic repair complications, introducing every year new meshes and materials. Lightweight meshes, composite meshes and biologic meshes are novelties of the last few years. We also take a look at future trends.

1. Introduction and historical notes

Hernia is an ancient word of Greek origin – "Hernios", meaning bud or sprout, reflecting in part the pathophysiological mechanisms of the disease. Hernias are very common, with an estimated prevalence of about 5% in the general population (about 8% in males and 2% in females). Going back to the distant past, Greek and Egyptian surgeons, as reported in the Ebers papyrus (1550 BC) proposed bending as a treatment for hernias. [1] Hippocrates (5th century BC) made the first complete description of the disorder and wrote about inguinal hernia in *De Morbis* and in *De Affectionibus*, suggesting enema therapy: "… if the patient is holding the enema, defecation will be and so healing …". Jumping to the 6th century AD, the Italian Paolo d'Egina in his work *De Medicina* describes his intervention for inguinal hernia; it will remain a classic until the end of the 18th century. [2] The main advances of this treatment proposal were: ligation and section of the sac with removal of the testicle or alternatively "ferrum candens" with removal of the testicle. Even though the first book about aetiology, morphology and treatment of hernia (*Practica Copiosa*) was written by Caspar Stromayr in 1559, [3] great contributions to inguinal channel anatomy with the description of important structures such as pectineal ligament and cremasteric muscles are due to Sir Astley Cooper in the 18th century. [4] A revolution happened on Christmas night of 1889 when Edoardo Bassini first operated a patient for hernia with his novel technique, repairing, for the first time, "the posterior wall" of the inguinal channel. [5] Until that moment the most diffused repair method was the so-called Czerny technique, focusing on the repair of the anterior wall of the groin, which resulted in about 100% of hernia recurrence. Bassini's merit was to have focused, for the first time, the attention of the surgeons on the posterior wall as the real repair location, lowering hernia recurrence rate from about 100% to about 10%. After an initial "explosion" of many techniques or variants essentially aiming to overcome the problem of tension on the suture line, the first cause of hernia recurrence, Shouldice was the first to introduce local anesthesia for inguinal hernia repair, managing patients in a day-surgery setting (his original technique, repair on 3 sheets instead of only 1, reduced the tension and consequently also postoperative pain). [6] At the same time, the era of prosthetic repair started at the end of the 19th century. One of the first hernia centers in Toronto (Canada) was dedicated to Earle Shouldice based on the original idea to concentrate the treatment of abdominal wall hernias in specialized centers; the concept diffused especially to the USA in the 1970–80s. A group of renowned hernia surgeons founded GREPA (Groupe de Recherche et d'Etude de la Paroi Abdominale) in 1979, later named EHS (European Hernia Society); later, in 1997 the AHS (American Hernia Society) and in 2004 the APHS (Asian Pacific Hernia Society) were founded. The official Journal for these societies, *Hernia*, was first issued in 1997.

2. Prosthesis in abdominal wall repair

At the end of the 19th century Witzel for the first time attempted inguinal hernia repair by using a silver mesh; other attempts using gold, silicon and other materials experienced a lot of complications and were quickly abandoned. [7] After the introduction of polypropylene by Nobel Prize winner Giulio Natta together with Karl Ziegler

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Table 1
Inguinal hernia repair. Surgical options

Approach	Non-prosthetic	Prosthetic
Anterior approach	Bassini, Shouldice, Postempsky, McVay, Marcy, Read, Condon	Lichtenstein, Trabucco, Rutkow, Flament, other published variants (Valenti, Donati, …).
Posterior approach	Nyhus, Read	Rives, Wantz, Stoppa, Kugel
Laparoscopic	–	TAPP, TEPP, IPOM

Table 2
Incisional hernia repair. Open vs. Laparoscopic repair: evidence about recurrence rate

Author (year)	Journal	Cases	Techniques	Recurrences
Goodney (2002) [42]	*Arch Surg*	712	Laparoscopic vs Open	No differences
Sains (2006) [43]	*World J Surg*	351	Laparoscopic vs Open	No differences
Kapischke (2008) [41]	*Surg Endosc*	1833	Laparoscopic vs Open	No differences
Sajid (2009) [44]	*Am J Surg*	366	Laparoscopic vs Open	No differences
Forbes (2009) [45]	*Br J Surg*	517	Laparoscopic vs Open	No differences
Sauerland (2011) [46]	*Cochrane Database Syst Rev*	880	Laparoscopic vs Open	No differences

in 1954, [8] this material was adopted for inguinal hernia repair and rapidly gained, after the establishment of original methods such as Lichtensteins', [9] Trabucco's [10] and other repair techniques, [11–14] a quick diffusion in the surgical community, and nowadays it is considered one of the most adopted materials for hernia repair. The advantages of prosthetic repair were immediately clear: reduction of tension on the suture line (sutureless technique), reduction of recurrences on long-term follow-up, reduction of postoperative pain due to absence of tension. [15] These advances together with diffusion of local anesthesia were the main factors of the modern gold standard of primary inguinal hernia repair [16]: an open prosthetic technique, in local anesthesia, with mesh adoption when possible in a day-surgery setting. Many techniques now fulfil these criteria; Table 1 summarizes the most diffused open techniques for inguinal hernia repair.

3. Day surgery and laparoscopy

Of course the rising costs of health systems all over the world have increased the pressure for the development and diffusion of the day-surgery model in the 1990s and even more during the last 10–15 years. [17] At the same time, the increase of laparoscopy also made its mark on hernia surgery with the first proposals and diffusion of TAPP, TEPP and IPOM. [18–21] Traditionally, advantages of laparoscopic techniques compared to open ones are: reduction of recovery time, early rehabilitation, reduction of pain, and better intraoperative vision (magnification of surgical field). [22] However, in hernia surgery these advantages are attenuated especially for primary inguinal hernias due to out-patient techniques, prompt rehabilitation (immediate ambulation, oral intake after 2 h, discharge 4–5 h after operation) with results not achievable with laparoscopy. [23,24] In fact, nearly 90% of inguinal and ventral hernia repairs could be achieved in a day-surgery setting. [25] Certainly laparoscopy gave a big impulse and contribution to a better understanding of anatomy offering the "new" posterior vision and also indirectly stimulated open hernia surgery to increase results and to find a solution to complications. The positive trend of implementation of the day-surgery model was confirmed in recent studies conducted in the USA in which data are demonstrating an increase of such recovery in the USA of about 300% between 1996 and 2006. [26,27] After achieving a mean incidence of about 1% of recurrence rate, virtually solving the problem, with much debate about the best techniques of primary inguinal hernia repair, [28] with several technical proposals, the attention of surgeons moved to complications of prosthetic repair such as: chronic pain, mesh fistulas, and mesh infections. [29–32] Therefore several reports of such complications stimulated industry to find new materials and technical solutions.

4. Inguinal hernia repair

Mainly due to the increase of indications for inguinal hernioplasty and the diffusion of prosthetic repair, many reinterpretations of traditional mesh repair methods have been published. [28,33–35] In Table 1 a schematic list of the most diffused surgical techniques is shown. Years of discussion in the literature, questioning the best surgical technique, best results, best material for mesh and so on, were concluded with a consensus conference of the EHS (European Hernia Society) resulting in some considerable achievements: The diagnosis of inguinal hernia is, with some exceptions [36–38] *per se* an indication for hernioplasty. The gold standard for primary inguinal hernia repair is nowadays an open mesh repair technique through an anterior approach in local anesthesia and when possible in a day-surgery setting. [16] Of course, these guidelines represent a consulting platform to be adapted for each patient and clinical situation. [39] On the other hand, it is generally accepted by the scientific community that laparoscopy has gained an important place among surgical approaches to recurrent inguinal hernias. An EHS board arrived at a consensus advising the laparoscopic or a posterior approach in cases of primary open repair, and *vice versa* an open anterior approach in cases of previous laparoscopic repair of primary hernia. [16]

5. Ventral hernias

While for inguinal hernias consensus conferences and evidence have shared results, published data and expert opinion have not achieve similar results regarding incisional hernia repair. There is a lack of consensus even regarding incisional hernia classifications. [40] With regard to the surgical approach the open technique and laparoscopy were compared from many years, and grade 1 evidence through the 6 published meta-analyses (Table 2) has shown that no differences were found in terms of recurrence rate and quality of life 6 months after operation in both groups. The advantages of laparoscopy compared to the open approach seem to be a quicker rehabilitation of the patient, less postoperative pain, less wound infection and better aesthetic results, while the disadvantages and limits are greater costs, long learning curve, longer procedure (due to tedious viscerolysis), reported accidental visceral and vascular damage, and

a higher incidence of visceral-prosthetic fistulas.[47] Contraindications are commonly taken to be abdominal wall disasters, patients operated on several times, and elderly patients with severe cardio–respiratory comorbidities. A third approach in local anesthesia[48] in well-selected patients[49] was proposed and is used by a small number of centers all over the world.[50–53] Unfortunately, local anesthesia for incisional hernia repair has not had a wide diffusion similar to inguinal hernioplasty among surgeons to date.

6. New devices and new problems

The increase of reports about the above-mentioned mesh complications[54] induced research on reducing mesh weight in order to reduce foreign body reaction, and therefore postoperative pain, and discomfort. A better biotolerability was tried to be achieved through composite meshes (absorbable–not absorbable), while against infections and fistulas meshes with the addition of antibiotics or anti-inflammatory factors have been produced. In fact, over the last 10 years various industries have developed and marketed: (a) Lightweight mesh,[55] (b) Coated mesh: oat beta glucan coated,[56] titanium coated,[57] (c) 3D mesh,[58] and (d) Auto-adherent mesh.[59] The advantages and results of these technical proposals remain questionable while there is still published clinical studies. For infected fields (hernia strangulation with bowel perforation or infected meshes) biologic meshes have also been experimented with (porcine dermal extracts or bovine protein derived meshes).[60] Unfortunately, also these new devices, in addition to their high costs, have shown some disadvantages (wound seroma, skin dehiscence with graft exposure without herniation, superficial and deep wound infections, hernia recurrence, graft failure with dehiscence, hematoma, enterocutaneous fistula, and flap necrosis).[60,61] On-going problems are: adequacy of long-term results (recurrence or prolapse of implants),[62] immunologic or allergic reaction – rejection of implants,[63] lack of evidence on large clinical studies, and the need for lower costs.[64]

A higher incidence of hernia recurrence due to reducted foreign body reactions and straightness of scar tissue is also a matter of debate. Also fully reabsorbable meshes such as vycril meshes were successfully experimented with in cases of contaminated fields or “abdomen apertum” such as after repeated laparotomies but they had a large incidence of hernia recurrence. Therefore the question remains the same: How to achieve a standard? Ideal conditions of “ideal mesh” after more than 50 years of research in the field have, to date, not been completely fulfilled by a single mesh. They are: low cost, low foreign body reaction, low immunological reactivity, good scar tissue reaction, resistance to infections, no induction of bowel adhesions. To date there is no consensus about the ideal mesh to use for elective primary inguinal hernia repair, for hernia recurrence and even more for incisional hernias. In contaminated fields the only “consensus” seems to be to avoid the use of non-reabsorbable meshes and for some authors to delay the final hernia repair to a second look after eradication of infection. The goals of future research should be to: (a) Reduce mesh discomfort; (b) improve biotolerance; (c) reduce mesh complications; and (d) maintain surgical results.[65]

7. New trends

It is interesting to note that some new experimental data have been published trying to overcome some problems of currently available meshes through the use of stem cells.[66,67] The aim of this research is to drive regeneration of the damaged transversalis fascia instead of reinforcement through strong cicatrization. Are we close to the next revolution for hernia surgery? What we can say is that only 40 years ago some established achievements of hernia surgery were unimaginable. Operating in local anesthesia, in a day-surgery setting, with prompt rehabilitation, very low surgical risk, obtaining only about 1% recurrence rate and limited long-term complications are results of modern hernia surgery worldwide.

8. Conclusions

The history of hernia surgery has shown much progress in terms of clinical results.

The introduction of prostheses and the advent of the laparoscopic approach during the last few decades has significantly changed “hernia surgery”.

Inguinal hernia surgery has had very good results with worldwide consensus and guidelines.

For incisional hernias and other ventral hernias such a consensus has still not been reached.

A further step forward is required to improve just “Good Results” of this kind of surgery, possibly through new research efforts in the industrial field of new mesh production. Perhaps the next revolution is just around the corner, looking at some promising attempts using stem cells.

Funding
None.

Disclosure statement
The authors have no conflicts of interest to declare.

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